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The single most important property of an actinide ion is its oxidation state because precipitation, complexation, sorption and colloid formation behavior differ considerably from one oxidation state to another. This has an effect on the actinide speciation controlling the true amount of contaminant that can undergo environmental transport. Uranium, neptunium, and plutonium can each coexist in several oxidation states in aqueous environments and can form a multitude of different species. We use a variety of physical-chemical characterization techniques to determine actinide speciation in aqueous solution and on aqueous mineral and bacterial interfaces. Solution speciation related to uranium mining and studies of uranium and plutonium on inorganic and organic environmental interfaces will be discussed.

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